Veracity of the archive: A research approach to the collection and verification of urban morphological records using qualitative data analysis software

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Abstract

Critical to the research of urban morphologists is the availability of historical records that document the urban transformation of the study area. However, thus far little work has been done towards an empirical approach to the validation of archival data in this field. Outlined in this paper, therefore, is a new methodology for validating the accuracy of archival records and mapping data, accrued through the process of urban morphological research, so as to establish a reliable platform from which analysis can proceed.

The paper particularly addresses the problems of inaccuracies in existing curated historical information, as well as errors in archival research by student assistants, which together give rise to unacceptable levels of uncertainty in the documentation.

The paper discusses the problems relating to the reliability of historical information, demonstrates the importance of data verification in urban morphological research, and proposes a rigorous method for objective testing of collected archival data through the use of qualitative data analysis software.

Studies into the transformational processes that affect the structure and evolution of cities are the fundamental purpose of research in the field of urban morphology. Through the use of various technological tools and methods, a holistic appraisal of a city's detail and development can be satisfactorily achieved (Amorim 2007; Bräuer-Burchardt and Voss; Kalisperakis *et al.;* Wiedemann *et al.* 2000). Furthermore, the provision of information that can influence the management of change in the urban environment is reliant on being able to capture cartographically the historical geography of the areas being managed or conserved. Maps of landscape units, or character areas, in conjunction with historical photographs, drawings and written explanations for each unit or area, provide those wishing to conserve or make changes with important context for preparing management plans (Whitehand 2007, 7).

A problem arises however, in that the original intent of most historical documents was rarely specifically directed towards architectural aspects of urban form. For example, historical records are frequently centred on social and cultural events that have taken place in city locations; consequently documents often reveal only fragments of information relevant to an architectural inquiry into urban form. Therefore the primary motivation for this research is in the question: is it possible to integrate these disparate data segments to form a representational historical jigsaw of a particular area of urban study? Furthermore, in order to establish quality in the data platforms of the research, what level of accuracy in archival information can reasonably be determined? How can the truth, freedom from error, and exactness of such documents be proven? In this paper, the authors will illustrate examples of questionable data quality collected in a student-based urban morphology study, discuss the reasons for these, and show how this problem can be satisfactorily addressed.

> Library and information scientists emphasize that people should consider who the source of the information is when trying to verify its accuracy. Philosophers, however, are much more likely to emphasize that people should look at what the information is. In particular, people are advised to consider the plausibility of a claim and the reasons offered in support of the claim (Fallis 2004, 11)

With the rapidly increasing volume of available data that is now possible through internet sources, and the correspondingly increased likely level of inaccurate information (Fallis 2004, 3), it has been necessary to implement a new process that extends traditional approaches to the field of morphological research by devising a method to correlate and

verify the available information. This paper will demonstrate how meticulous triangulation and cross-referencing of primary and secondary documents can result in an accurate account of the urban condition of the study area. This has been achieved by finding connections between the isolated fragments of data, noting overlapping characteristics and forming educated interpretations. Only when these sources have been comprehensively examined and verified is it possible to move on to the analytical aspects of the research. The tools to achieve this process have been developed from qualitative data analysis software (*Atlas.ti*); and the authors describe how the software has been used to facilitate the organisation of data, in order to document the triangulation of information as evidence of the verification process.

By involving undergraduate students in the task of data collecting and mapping, the inherent problems of scale and resource-intensive demands for morphological research was addressed. However, the subsequent issue of integrity of the student course work and research-based assignments became a catalyst for investigation, which led to revelations of inaccuracies in the archival material itself. The rationale is essentially about the verification of documentation in the process of conducting historical research, which inspired the authors to devise a method of collecting, verifying and compiling architectural history.

Traditional approaches to data collection in urban morphology

> ...to understand the complexity of the regional structure and morphological character of present townscapes, historico-geographically informed townscape analysis is necessary (Conzen 2004, 53)

It is common for researchers in urban morphology to source data from maps, plans, surveys, historical documents and archaeological work, particularly when accounting for evidence of structures no longer available for in-situ observation (Heineberg 2007, 8; Pinho and Oliveira 2009, 105; Whitehand *et al.* 2009). In the cases where historic urban fabric is intact, field work can reveal evidence of formation procedures, enabling a methodology for the interpretation of towns and their components (Cataldi *et al.* 2002, 3). Furthermore and more recently, aerial photography and GIS systems have provided a comprehensive and detailed source of data for large-scale morphological studies (Koster 1998; Pauleit and Breuste 2011, 22). Micro-morphological study, however, at the level of elements of individual buildings (Larkham 2006, 126) frequently requires additional material in order to assemble a three-dimensional account of the built forms. This material

includes historical photographs and building drawings, including plans and elevations normally sourced from local authorities (Chen 2012, 131; Larkham 2006, 121).

Urban morphology in Australia and access to historical data

Australia shares with America many characteristics of city block settlement patterns (Siksna 1997) as well as symptoms of wanton turnover of urban form, through developments driven by successive economic cycles. In the world context, towns and cities in both countries are relatively young, with the earliest towns spatially minimal compared with the scale of their later transformations. Rapid change is a constant, and consequently the study of urban morphology is looser, less organised and ordered than in Europe (Conzen 2001).

Whereas in Europe it is still possible in historic centres to assess morphological patterns through the interpretation of existing forms, the paucity of historic building stock within the existing urban fabric in Australia requires a far greater reliance on archives and records to formulate morphological analysis. Nevertheless, due to the relative youth of its cities, as well as a background of rigorous tradition in British surveying, recording and archiving practices, a richness of secondary data suitable for morphological research is readily available.

Because of its relatively recent origins rising from the antecedent penal settlement, Brisbane has been reasonably well documented through various sources that have recorded many aspects of its establishment and subsequent transformation; a sound basis for the city's selection as a case study for this research. Under the direction of the authors, and organised into working groups, the participants collected and catalogued historical data from all known and available sources. This work required the participants to access the archives of various government and local council collections in order to amalgamate information. Critical documents collected included survey maps (cadastral property delineation), pictorial evidence (photographic records), and literary descriptions of places and events (books, newspaper records, and postal and telephone directories). The outcome has been a broad-based central city survey of archives, collections and repositories, which has resulted in a comprehensive data compilation.

Types of historical data collected

Pictorial evidence, survey maps and plans, and literary descriptions comprised most of the documentation collected; these exists in either physical or digital form and are primarily

sourced from repositories, libraries, archives, government collections and auxiliary internet sources. One significant published document ‘Brisbane: Archives and Approaches II’, is a guide to Queensland archives and their potential uses and dates from 1988 (Fisher and Jenner 1988). Albeit now somewhat out-dated, it substantiated the scope and application used by the students and authors when researching the antiquated build fabric of Brisbane city; published by The Brisbane History Group (formed in 1981), it is one of many key publications from this group that provide a rich source of information for identifying and dating historical buildings. Another example is the publication of a series of historical walking tours of Brisbane CBD (Bennett *et al.* 2002), which showcase the surviving warehouses and light industrial sector.

Pictorial evidence

Historic photographs (both aerial and perspectival) are the most significant visual resource in assessing the historical streetscape. Not only is the photographic record ‘hard evidence’ of a built reality at a particular time, it furthermore compensates for the scarcity of drawing documentation of such past building forms. The primary use of early photography (as became apparent in the case study research) was not to document the city and its streetscape, but rather to capture the city’s major events that included: floods, fires, new businesses, tramway systems, riots, protests, international visitors, parades, public events and ordinary day-to-day life. Photographs initially serve the particular function determined by their creator, and this often differs from that sought by researchers (Marwick 1989, 201). Consequently, the built fabric is subordinate in the majority of historical images, with often only glimpses of contiguous architectural structures, and so the direct use of photography for assessing historical urban form has been inhibited.

Figure 1- Early view of Queen Street, Brisbane, ca. 1859 (Source John Oxley Library, State Library of Queensland Neg: 8299)

Australia's earliest photograph on record is a daguerreotype taken in Sydney's Macquarie Place on 13th May 1841(Barrie 1996; Davies 2004, 2; Davies *et al.* 1985): the earliest known detailed photograph of Queensland's early settlement (Figure 1) dates back to 1859 and depicts Queen Street (Unidentified 1859), although two photographs depicting views of Brisbane and of Drayton, both dated 1858, are the earliest images in the John Oxley Library photographic collection (Fisher and Jenner 1988, 26) currently inaccessible digitally. The fortunate development of early photographic technologies in Queensland's formative years means that photographic pictorial evidence is available as a most valuable foundation for architectural investigation and has made it possible to reconstruct a large part of Brisbane's morphology from its origins to modern day.

Photographs of the locations of the Brisbane City streetscapes under review were captured sufficiently and frequently during various pivotal moments in history, a factor significant in the selection of case study areas. The case study site along Charlotte Street (Figure 2) formed part of the notorious area of Frogs Hollow; this was the site of the warehouse district, a low-lying area close to the early riverside wharves which gained its name due to the swampy conditions.

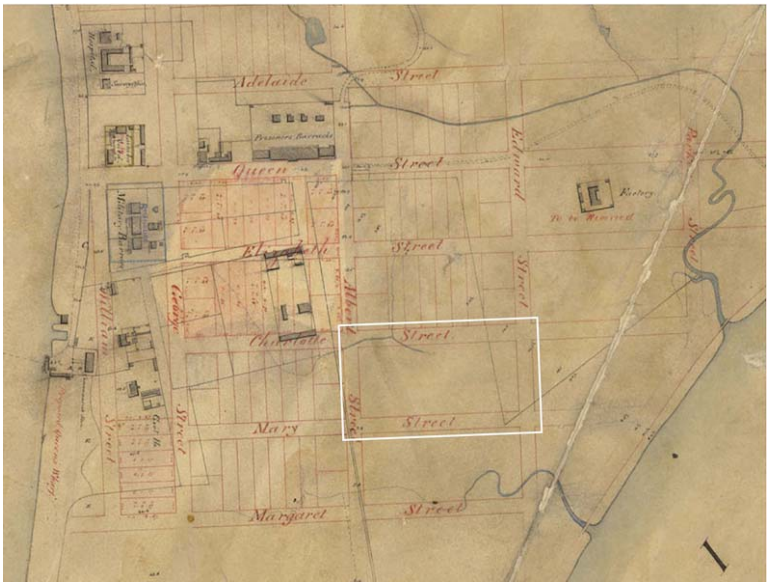

Figure 2- Detail from *Plan of Brisbane Town* 1842 (Wade and Marriott, 1842) showing case study area indicated by the white box. (Source Queensland State Archives Digital Image ID 2774)

Consequently it has suffered nine major floods from 1841 through to 1974. Furthermore, two major fires in 1916 and 1944 also affected its development. The largest source of flood photographs came from the 1893 flood: these, however, offered only incomplete depictions of the façades because of the enveloping body of water.

As economic conditions and building construction systems improved in Brisbane, the city buildings steadily increased in height, revealing new perspectives of the city from novel vantage points such as the top of Perry House (built 1911-1913).

These allowed panoramic photographs that depicted many building façades, captured in full view without immediate building distortion, which have proved invaluable for historical building arrangement and documentation. Perry House (now The Royal Albert Apartments) was at the time the tallest building in Brisbane, standing at 123ft (37.5 metres). Fortunately, Charlotte Street appears in many of the 1913 photographs taken from the top of Perry House, particularly the section of street in review (Figure 3).

Figure 3- View from the Perry Bros. Building at the corner of Elizabeth and Albert Street, ca. 1913 - looking across Charlotte St to Mary St. (Source John Oxley Library, State Library of Queensland Neg: 38590)

The majority of pictorial evidence was sourced through the National Library of Australia's innovative free online search engine, named *Trove* (National Library of Australia 2009), which guides users straight to the source of Australian online resources. *Trove* searches thoroughly though online library collections, cultural and educational institutions and many more Australiana sources.

Newspapers/media events

Newspaper articles documenting events such as floods, fires (Figure 4), social events, criminal activity, merchant advertising, architectural precedents, and city developments such as property sales and planning were important sources.

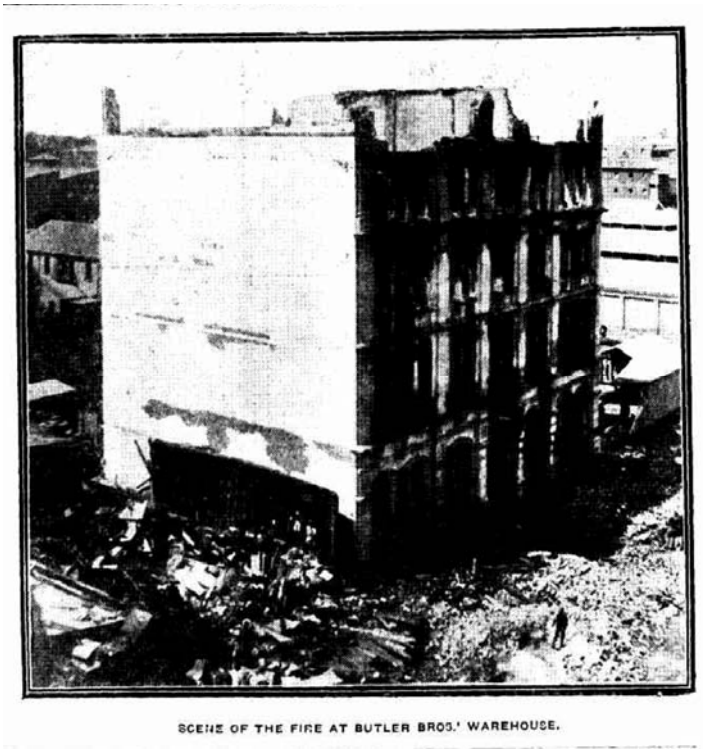

Figure 4- the Charlotte Street Blaze *The Brisbane Courier* 1916 (Unidentified, 1916) (Source National Library of Australia)

Frogs Hollow was rife with antisocial behaviour and historical detail from contemporary articles, reports and publications provided valuable information. Advertisements sourced from early archived prints of *The Brisbane Courier* (1864-1933) and *The Courier-Mail* (1933-present) often provided street addresses, renovation dates, occupants and other useful information, such as advertisements for architecture firms. Many articles and advertisements depicting the details of these events were often accompanied by photographic evidence providing additional validation. *Trove* once more served as the portal which facilitated the procurement of digitised historical Queensland newspapers chronicling the development, events and populace of Brisbane city.

Survey Maps & Plans

Printed material, including building descriptions and documentation drawings were also useful for researching and documenting the built form. Documents such as planning/construction documents, site surveys, historical society records, and building history information were an invaluable source of verified and measurable information. Construction drawings accessed from the architectural companies responsible for each modern building were a valuable resource, however, although readily locatable, copyright and confidentiality legislation can place unavoidable restrictions on access to these documents. Drawings for the removal of buildings, such as required demolition

documentation often included site plan documentation which clearly indicated the structures to be demolished and those to be retained; however this is only available for more recent streetscape elevations since demolition documentation was only compulsory after the 1975 Queensland Building Act.

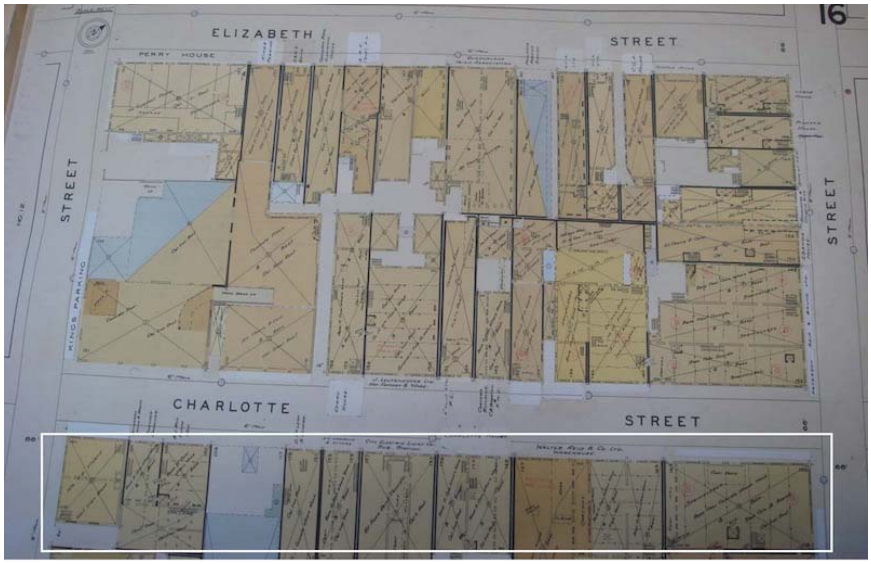

Figure 5- Page depicting study area taken from *Index to City of Brisbane- Detail fire Survey* 1951 (Mahlstedt & Son, 1951) (Source Brisbane City Council)

Detailed survey information often followed major flood and fire events, for example, *The Brisbane Fire Survey of 1951* (Figure 5) (Mahlstedt & Son 1951).The development of civic infrastructure, including early water and sewerage plans, linked to existing construction drawings, helped researchers site buildings into context within the streetscape. The Metropolitan Water and Sewerage Board of Brisbane's 1911 plans depict key information such as tenant or building names, number of floors and utilities layout, all within measured plans that record each urban block in the city. These plans are split up into sections as imperial-scaled drawings on pages of a booklet. The amalgamation of historical architectural documentation with current accurate 'as constructed' site surveys will ameliorate the process of re-constructing former city fabric.

Brisbane city council records and other Queensland state archives such as the Museum of Mapping and Surveying, and the National Library of Australia, are the source of reliable plans and auxiliary cartographic material. Furthermore, the source of primary historical plans such as original surveyed plans dating from the 1840s can be obtained from various historical societies' publications, and through the *Trove* search engine (National Library of Australia 2009). The Royal Historical Society of Queensland, Queensland's peak history body since 1913, provides a wealth of documented maps and plans from its library and

museum in which documents, manuscripts and artefacts relating to the state's history are preserved (The Royal Historical Society of Queensland, undated).

Almanacs, postal records and trade directories

Historic Queensland directories and almanacs provide a plethora of historical information that may allow reconstruction of the commercial organisation of a street. Not only do directories provide names of businesses, institutions and societies, they can facilitate the identification of individual buildings, structures and sites which therefore aids to recreate the spatial configuration of a street, block, suburb or city over time (Fisher and Jenner 1988, 83).

The complete extant Queensland directories and almanacs, some published as early as 1859, have been archived in various state and national archives as reproduced sources on microfiche (Fisher and Jenner 1988, 16-17). These include Brisbane-specific archives such as:

- Queensland Post Office Directories, Brisbane 1868-1919 (Archive CD Books Australia 2005);
- Pugh's Almanac Brisbane 1859-1927 (Pugh 2007);
- Verney's Almanac, Brisbane 1899 (Verney 1982); and
- Shaw's Brisbane Directory & Squatters Guide, Brisbane 1876 (Shaw 1875).

Early postal records of merchants provided substantial usable evidence. Each merchant was listed sequentially in building order from street intersections, plot numbers were also provided enabling the exact location of the merchant to the city plan. Approximate dates of building constructions are also able to be extracted from this type of data when used alongside title information (Fisher and Jenner 1988, 70). It is also evident that over the years street addresses (introduced in the twentieth century) and lot boundaries often changed, or were incorrectly identified in the course of a street's development (Fisher and Jenner 1988, 70), which in itself presents a challenge in the verification process.

Unlike conventional directories, almanacs provide a wide range of information about individuals, locations, facilities and events during the featured years. Written descriptions and traders advertisements found in these 'yearbooks' provided the most efficacious information for the urban morphological study, as they created crucial links to building information such as street addresses and the development of individual buildings.

Audio-visual records

The use of audio-visual documentation was not included in this research as there were limited relevant resources to examine. The earliest surviving film catalogued in the National Film and Sound Archive of Australia documents the 1896 Melbourne Cup (Sestier 1896). Most other early films depicted only the interesting and significant events of the time. In Brisbane, only the most notable streets and buildings were captured in early films, such as the opening of the Queensland Parliament in 1899 (Wills 1899a) and views of the busy intersection of Queen Street and Victoria Bridge in 1899 (Wills 1899b). The sample area for this morphological research was in the less prominent Charlotte Street, and as such no useful audio-visual records were obtained.

Non-traditional records

Today, in our connected world the evolution of social networking platforms and public online forums, people connect through social media platforms that operate as portals to valuable unpublished resources, private collections and personal chronicles of historical events.

For example, at an international scale and influence, Internet communities such as *SkyscraperCity*, created in 2002, are dedicated to continual simultaneous dialogue on the global built environment including the sharing of images, facts and insights of buildings from multiple cities in the world, including Brisbane (Skyscraper-City).

At a local level, the Facebook group *Lost Brisbane* digitally gathers likeminded novice historians to share and discuss historic information. Created in 2011 by John McDonnell, the 56-year-old amateur history buff has launched a page that allows for the dissemination of pictorial and literary resources, it already has 12000 followers many of who have posted their own private historical artefacts (Minchin 2013).

These kinds of resources that are in the possession of a large audience, may yield the breadth of information not usually retained in formal archives, and therefore have the potential to make an enormous impact on the latitude of data availability.

Premise for validation of research data

Wang and Strong contend that high quality data should be ‘intrinsically good, contextually appropriate for the task, clearly represented, and accessible to the data consumer’ (Wang and Strong 1996, 6). Their concept of ‘fitness for use’ within a data manufacturing system

identifies the inter-relating roles of data producers, data custodians, and data consumers (Strong *et al.* 1997; Wang and Strong 1996). However, documentation that has been primarily sourced from archival records through a historico- interpretive research sequence of search, evaluation and narration (Groat and Wang 2002) has the tendency to include inaccuracies, either by those who generated the data, or by those responsible for its categorisation; for example, an archival sample can have been mislabelled by either the author or cataloguer, or even both! The necessity for verifying information from these sources is therefore imperative to ensure the quality of the research prospect.

Fielding and Fielding's methodological approach to the interrelationship of qualitative and quantitative data suggests that multi-method research can be integrated through a systematic approach of integration and triangulation. " Because the methods are more varied than identical, the multiple observations provide convergent validation" (Fielding and Fielding 1986). Fallis points to David Hume's philosophical grounding in the consideration of four important areas when verifying information: 1) *authority* -who testifies, 2) *independent corroboration* -how many testify, 3) *plausibility and support* -what they testify, and 4) *presentation* -how they testify. Through these aspects Fallis demonstrates how work in the epistemology of testimony is relevant to the appreciation of how to verify the accuracy of recorded information (Fallis 2004).

A series of criteria arise from the literature regarding data reliability, many of which are contiguous if not overlapping, that nevertheless establish efficacy of information for architectural purposes:

- *intrinsic* (data quality patterns – accuracy/ objectivity/ believability/ reputation);
- *accessibility* (data quality patterns – access security);
- *contextual* (data quality patterns – relevancy/ value-added/ timeliness/ completeness/ amount of data) and;
- *representational* (data quality patterns – interpretability, ease of understanding, concise representation, consistency)

  (Ge and Helfert 2007; Strong *et al.* 1997; Wang and Strong 1996).

It is recognized that a significant number of different sources of information is needed to verify and help construct architectural information, including, importantly, surviving

physical fabric which can be a critical point of reference connecting historic with existing conditions.

This challenging endeavour of analysing the breadth of historical documents, including bridging any gaps in information throughout the process, can nevertheless lead to the production of ‘reverse-engineered’ mapping documents including building plans, sections and elevations. Whitehand has suggested that it is important to assess the level of variability when dating by architectural-period characteristics, and that, through identifying broad patterns in results, a level of reliability in the data can be justified (Whitehand 1979, 566).

Two separate streams of research that required examination emerged from this urban morphological study; firstly, undergraduate student productivity and performance; and secondly, the veracity of the retrieved archival documentation. Initially, any deficiency in meticulousness, prehension, circumspection and acuity **in** a student participant’s research deportment was often self-evident: however, whilst verifying and modifying a sample of their work, it became apparent that some errors were due to inaccuracies in the archives themselves.

Selected for rigorous inspection in anticipation of its high level of historical accuracy, a single orthographic streetscape projection sample was interrogated for a further stage of analysis. This specific study was apparently one of the best documented; however, it became apparent early in the investigation that several major inaccuracies were present.

Student participant’s credibility & research skills

Empirical evidence indicates that as well as academic integrity and ability, ignorance, dishonesty and misconduct in higher education students abound in tertiary institutions (Brimble and Stevenson-Clarke 2005; Devlin and Gray 2007; Kibler 1988; Perry 2010). Research undertaken into undergraduate academic behaviour shows that academic misconduct, due to internal and/or external pressures, inadequate academic skills, and a lack of appreciation as to what constitutes academic misconduct (Devlin and Gray 2007, 181) often contributes to ineffectual research results. One example of academic misconduct, often due to a student’s poorly-developed research capabilities, is the falsification of results. Studies show this to be a commonplace activity (Brimble and Stevenson-Clarke 2005; Devlin and Gray 2007), and more alarmingly, reveal that students regard it as “minor cheating” or “not cheating at all” (Brimble and Stevenson-Clarke 2005,

32) further fuelling students' misunderstanding as to what is acceptable and resultant malpractice.

The reasons behind this kind of academic misconduct are many. One theory suggests that students are somewhat 'corrupted' by a preoccupation with high academic achievement, so if they are compelled to produce a document within a restricted schedule, the student is driven to fabricate results or modify them to fill gaps in information. It is conceivable that the student may wish to gratify the lecturer with an apparently impressive study, knowing that verification may well not be carried out, or if it were to be done, by then the student would no longer be at the institution. Substantial discrepancies in the streetscape elevations, like those shown in Figure 6, may therefore be explained simply by student behaviour when pressured by an obsession with high achievement or alternatively, fear of failure.

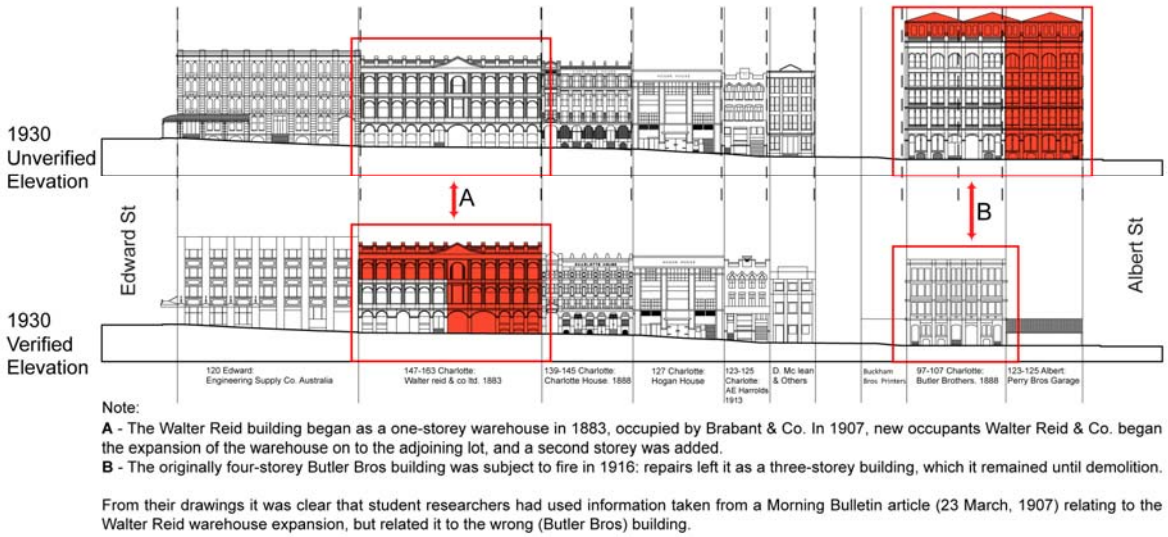

Figure 6- Illustration depicting inaccuracies in mapping information. (Source: Authors)

Reviewing the student's output confirmed the shortfall in their research skills. Even when the information collected was acceptable, careful scrutiny could reveal that their approach to analysing, interpreting and applying the data was substandard.

Allowing for the student's lack of experience, it is plausible that they may have misinterpreted key historical details attributed to a streetscape, particularly those of written accounts and descriptions which lack an auxiliary geographic or pictorial accompaniment. A novice researcher may not have sufficient "logic, intuition, persistence, and common sense" (Denzin and Lincoln 1998, 252) necessary to discover and evaluate relevant sources and various inconsistencies in their data archive and the final product reflects the student's

inability to establish and rectify inconsistency, even with the appropriate evidence at their disposal. Paradoxically, the new verification method presented in this paper would be the very process that could have assisted these students, and averted the errors in their reports.

Inaccuracies in historical documents

Inaccuracies in some primary historical sources became apparent during the scrutiny of the students' research outputs. Often after finding and verifying a disparity in a student's collected data it was discovered that some inaccuracy actually stemmed directly from the municipal archives themselves. Not only is it crucial to firstly examine all key primary sources linked to a study in order to 'organise, evaluate and interpret as verified evidence' (Godfrey 2006, 28) but it is also necessary to critically appraise the selection, transfer and interpretation of the data by subordinate researchers if there is to be a legitimate contribution to the field of urban morphology. Additional misinterpretation occurs when inaccurate written accounts have been linked to verified archival documents. By association, these suspect accounts then appear superficially accurate and applicable. Subordinate or novice researchers may be unaware of this possibility, and output thereby distorted, and Fallis underlined the importance of considering the source of a piece of information when trying to verify its accuracy, and in particular the 'past track record' of the information source (Fallis 2004, 469). The many processes to which any historical documentation may be subjected, from its initial production, cataloguing, to its current state of preservation can facilitate inaccuracies; sequentially creating a cumulative incidental effect. Modern processes of duplication, by means of digitisation from analogue to digital, intrinsically tied to the mode of information, have also affected the accuracy of historical archives.

Modes of information – Analogue & Digital

A researcher frequently encounters various modes of documentation whilst in the data collection phase of a study. These can be categorised into non-digital, surrogates of non-digital (digitisation of physical artefact) and "born digital" material (Hampshire and Johnson 2009, 397). Errors in historical manuscripts and documents found in the archives could be attributed to incorrect labelling or cataloguing, either by the historical archivists or by the technological processes they are subjected to. Manual labelling errors, particularly with digitised duplicates, may be produced if the archivist incorrectly reads the document's identification. Alternatively, incorrect labelling may be due to an incorrect or estimated classification applied by the archivists to a document lacking intrinsic

information which has not been substantiated by other means. Digitising errors are not only the direct fault of the archivist, but also due to the use of emerging technology. The problems found in digitised records predominantly relate to the historic literary descriptions, particularly from archived newspapers, which have been scanned, compiled and filtered using the text recognition process. For example, in the case study sample, many digitised words for Charlotte (Street) & Brabant (Building) were either misspelled or completely jumbled, allowing the researcher to easily miss pieces of historical evidence when relying on search words alone. While reviewing the students' work, the authors recognised this as a particular problem. For future searches performed in the newspaper repository, any visitor to the online archive should be aware of the necessity to supplement the digital search by also checking and intelligently deciphering badly printed text. However, a more direct influence on the veracity of the student's outcome was from their own collection and recognition process.

It was obvious from the outset, whilst reviewing a student's historical catalogue, that problems with the accuracy of documents arose in the information retrieval phase, due largely to the students' efforts in digitising resources that were unobtainable in their original physical form. Distortions arose when two-dimensional documents such as maps and plans were ineptly or carelessly photographed or scanned. Much information used in for reports and reconstructions of urban layouts was taken from digitised duplicates, and these were used without repeated reference to the analogue originals, restricting the ability to review and reduce any mistakes made from digitisation.

Figure 7- Illustration depicting compilation of block using segments from municipal water and sewage plans. (Source: Authors)

For example, the photographs of the 1911 municipal water and sewerage building plans, which exist as sections in booklet form, were subsequently pieced together and became the definitive base for the urban layout from 1911 and thereafter (Figure 7). Because many of

the students' photographs were blurry, distorted by the camera lens and lacking any scale guides, the assembled base plan had limited documentation value yet was used nonetheless. Conversion of imperial to metric measurements may have been a further reason for dispensing with a scale, as this process appears to be a problematic concept for modern students.

Pictorial inaccuracy and distortion

Photographic images, particularly historic photographs which pre-date computer technology, serve "as determinative evidence" (Groat and Wang 2002, 154). The doctoring of historical photographs was not easily performed and therefore negligible before computer technology emerged, so they are generally permissible as verified evidence providing there is little to no distortion. On the other hand, the dates, location (and creator in some cases), may not always correlate, which may compromise their acceptability. In addition, the reproduction of visual evidence may be affected due to distortion by the camera lens, by the condition of the negative, during photograph reproduction, by printing, and then eventually through the process of digitisation of the physical artefact. Despite the availability of colour photographic methods in Australia since the beginning of the 20th century, the photographs in the archives were either grey-scale or sepia. The lack of colour in a photograph generally affects its readability, particularly when identifying edifices: shadows can be mistaken for structural elements and building voids, or cause other confusion. For example, windows were often indistinguishable from darkly painted elements or were distorted by shadows. Natural colour photography, which enhances visual recognition and thus allows reliable triangulation to other supporting evidence, would have reduced this kind of ambiguity.

Paintings and sketches were of variable value for researchers, largely because 'artistic licence' in depictions, especially in terms of relative size and perspective, rendered them largely unusable for detailed documentation. They do, however, have a general value when considering the overall city's timeline of development.

A new multi-modal verification method

The process of verification was not simple, nor was it a process easily captured as a categorical written description. The method used in evaluating the participant's contribution and the validity of the historical evidence was developed as a transverse adaptation of the interpretive-historical research method.

The allegory of historical evidence

The method outlined for interpretive-historical research by Groat and Wang (Groat and Wang 2002, 137) is identified as a process of *collecting* data/or historical evidence, *identifying* and organizing sources and facts, *evaluating* through analysis and triangulation, then finally *narration* which in this case, is based on acceptable technical drawings. At each of these 'phases' of research, all of which overlie one another to some degree, *interpretation* is seen as an underlying practice throughout (Groat and Wang 2002, 138). Interpretation is particularly significant during the data-collection 'phase'. Because interpretation is directly affected by the veracity of the content gathered and analysed, it is imperative to verify dates, events, building typologies and measurements using a diverse range of sources in order to eventually produce an accurate representation of the urban morphological development.

Primary sources particularly need the specialists' skills of an experienced researcher to extract their appropriate and significant information: many students do not have the time or the knowledge to do this (Marwick 1989, 199). Contrary to Groat and Wang's chart of interpretive research (Groat and Wang 2002, 137), *interpretation*, by way of physical and allegorical triangulation, is necessary throughout all phases of research, particularly throughout the *collection* phase. Thorough triangulation, therefore, is needed at all stages in order to audit and extract most of the necessary and factual information from primary resources for historical architectural research.

Triangulation

> *Triangulation implies the use of multiple methods, diverse data sources, multidisciplinary investigators and various theories.* (Melkert and Vos 2010, 36)

Triangulation, in a historical research context, is best defined using the *Encyclopedia of Research Design's* broader context of quantitative and qualitative research approaches. Most often the definition of 'triangulation' outside of terrestrial surveying application is defined as 'methodological' (Hastings 2010) effectively pertaining to "the combined use of two or more research methods within a strategy of convergent validity" (Lewis-Beck *et al.* 2004, 1143). Referred to as "mixed methods or multi-method research" (Hastings 2010), the type of 'triangulation' used in this study wavers between methodological and tangible validity, often trending closer to the navigation, military strategy and surveying contexts from where the term originates (Blaikie 1991, 116; Jick 1979, 602; Smith 1975, p273), whereby a location is accurately extracted from three known points (Blaikie 1991, 118;

Smith 1986). The triangulation of historical evidence preferably requires the application of three multi-modal historical resources, specifically cartographic material, photographic evidence and written history, not only to construct validation for each ancillary resource, but also to help assemble the *narrative* necessary to construct virtual reconstructions of past architecture. Studies that employ triangulation typically yield one of three outcomes: convergence, inconsistency, or contradiction (Hastings 2010).

An accomplished researcher will automatically question every inconsistency that arises whilst *identifying* and *evaluating* archived documents. This is a form of triangulation or cross-examination which will subsequently develop an educated and evidence-based conclusion. There is a level of wisdom necessary in both the *identifying* and *evaluation* phases whereby 'inferential' connections could be made through the 'proximity of dates, reasoned interpretations or logical deductions' (Groat and Wang 2002, 157). In the context of this particular historical research, triangulation is used foremost as a validation strategy, as had initially been the case in the social science research 'sphere' (Jupp 2006, 305). The triangulation practices used in this study, including the use of an amalgamation of written, pictorial and cartographic triangulation conventions, are given below.

Triangulating pictorial evidence

All reconstruction methods that determine past building forms (either digitally or non-digitally) require a level of intrinsic assumption of the actuality of the visual evidence. Because pre-digital photography was the primary form of pictorial evidence used in the study, the visual authenticity was rarely questioned. Researching the authorship of key photographic evidence helped to identify dates and locations of unidentified images. Comparing congruous indicators created by the quality, pictorial dimension, sepia colour grade and overall appearance of the photograph bolstered the verification process. Dates were also verified with written evidence such as newspaper print and personal records, with interesting results. Image subject or depiction additionally dated the photo, such as those depicting pivotal flood and fire events, which in turn helped bridge the gap of any missing information and correct erroneous descriptions. A number of common photographic distortions such as those produced by the camera lens can be managed and rectified through the understanding of period architectural style and geometry (Whitehand 1979, 566). However, because many images depict buildings from an angle and are rarely an orthogonal representation of the elevation, the profiles of the buildings were difficult to link to other evidence. Periodically, advertisements on the sides of these structures helped

to identify the structure and/or the merchant occupying the building. Similarly, verifying perspectival ground level images with aerial photographs by identifying and matching roof pitch and the shadow length, not only helped identify the location, but also the approximate storey height of a building. Equally, the aerial photographs gave insight into the plan and cadastral boundary documents; however, most aerial shots are not exactly perpendicular to the ground, which will skew the building footprint.

Major events often captured pictorially in newsprint enabled the verification of building location, description and occupation. One account in particular helped discover a mistake not only in the student participant's illustrations, but also in a key archived photograph used to verify the street sample (Figure 8). The obviously post-fire Butler Bros building in the photograph in question was incorrectly labelled as originating from the year before the fire, which made it contradictory and subordinate as supporting pictorial evidence. The authors have subsequently alerted the state librarians, who have rectified the mistake.

Figure 8- Looking North over the City of Brisbane, 1917. Photograph taken by P.C. Poulsen.
Originally dated in the State Archives as 1915, proven inaccurate through the Author's process of triangulation. (Source John Oxley Library, State Library of Queensland Neg: 123132)

Fundamentally, the streetscape reconstructions (by both the students and the authors) were based largely on colonial documents supplemented by cross-examination with the heritage buildings still present in the urban fabric. The historical documents collected by both the undergraduate students and the authors, of primary use for cartographic purposes, were

questioned using systematic triangulation and cross-examining of converging resources such as neighbouring building information and written accounts of the buildings' attributes; which in turn has laid the foundations for the development of a methodology that can be applied to future architectural historical research.

Computer aided photographic triangulation – Photoshop

> *The accuracy of this information and the ingenuity of the interpreter in reading clues and translating them into dimensions will determine the validity of the result.* (Kane 1977, 38)

For the photographic evidence to be viable in identifying and measuring the architecture of the past, images must first be connected and cross-examined with an amalgamation of supporting historical records, requiring a level of educated resourcefulness, as well as a good memory and interpretation skills.

Contemporary emerging technologies were unavailable for this study due to the limited resources available at the time of investigation. These new technologies revolve around the use of computational software specifically developed to extract three-dimensional data from photographic evidence and surviving edifices (Bräuer-Burchardt and Voss; De Luca *et al.* 2006; Styliadis and Sechidis 2011). Consequently, the methods and techniques used are not far different to those specified in Thomas Kane's 'The Use of Reverse Perspective in the Deduction of Plans and Elevations from Photographs' (Kane 1977, 31): however the significant variable is the introduction of impromptu use of all-purpose digital design software tools.

Computers have provided new ways of analysis (Groat and Wang 2002, 154) making it even easier for information to be "extracted from a photograph by a human observer using common reception patterns together with usual construction rules"(Bräuer-Burchardt and Voss, 1). Such methods of analysis belong to the technique of 'photogrammetry' and 'photo interpretation' (Mikhail *et al.* 2001, 1). Mixtures of traditional and contemporary photogrammetric methods have been employed in the inspection and modification of the streetscape.

> *Photogrammetry is the art, science and technology of obtaining reliable information about physical objects and the environment through processes of recording, measuring and interpreting photographic images* (Tarek *et al.* 2008, 3845)

Photogrammetry has been an accepted technique for capturing three-dimensional urban environs (Tarek *et al.* 2008, 3845) through the measurements taken from two dimensional photographs (Egels and Kasser 2002, 1), however historical photographic evidence is affected by a range of issues due to its historical nature. The photogrammetry of surviving buildings has been demonstrated in recent studies as an ultimate and highly accurate method of measuring in-situ architectural artefacts. A process of photogrammetry was directly implemented by both students and authors for the buildings that are available for physical measurement today; however, these techniques could not be used for buildings no longer in existence, so that 'photo interpretation' was employed. This is a manual method heavily relied on for "the extraction of qualitative information" (Mikhail *et al.* 2001, 1) which supports photo-measuring techniques for those buildings no longer physically accessible or with non-metric photographic evidence.

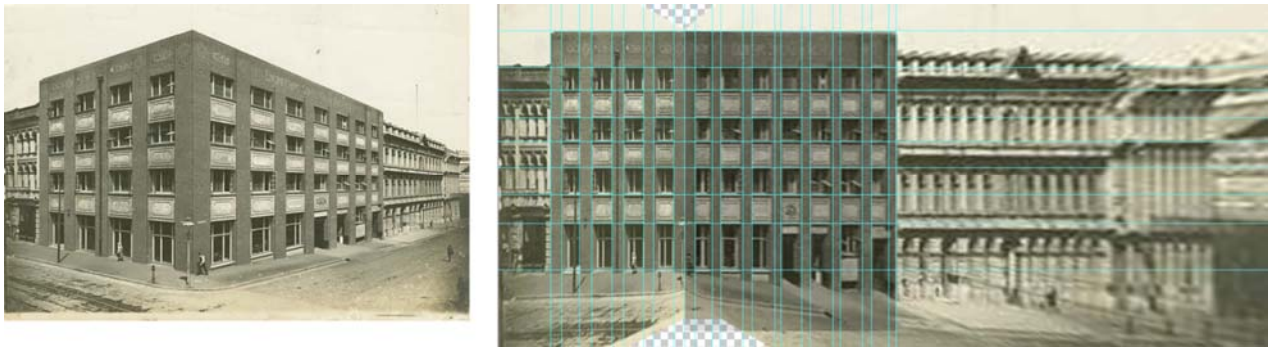

Figure 9- Screen shot depicting the early stages of the 'rectification' process for the Engineering Supply Co. of Australia building façade, situated on the corner of Charlotte and Edward Street in Brisbane.

Plan and façade verification and re-creation was aided by the use of graphic design software to manually 'rectify' images, then Computer Aided Architectural Drafting (CAAD) software was used to trace, stretch and appropriate into the documentation as best as possible. Figure 9 depicts a building façade photo before and after its initial Photoshop-aided 'rectification'. The resultant 'rectified image', once traced and stretched into position in the CAAD software, is then hidden or discarded as its purpose as a gauge has been realised.

Re-creating the history of buildings that have not survived the urban transformation has been a difficult endeavour for both the students and authors. Fortunately, photography has provided valuable evidence of the early stages of development due to Brisbane's being a relatively recently-established city.

CAAD base: Preparation of geographical plan and elevational attributes.

The data sets benefited from recent CAAD developments. The numerous base plans produced could be verified using various historical and current cartographic evidence including aerial photographs. CAAD software was not only used as a platform for developing results, but also for verifying historical resources in the same operation. The process of layering information is a critical feature of such software and was extensively used to cross-examination numerous plans. Evidence-rich historical survey plans, along with the current and more accurate plans of present day were layered in AutoCAD and directly used to verify and modify participants' work.

Architectural drafts/archived construction drawings

By using the validated pictorial information sourced, the dimensions and proportions of each façade were fundamentally matched to all the evidence gathered for each edifice and their architectural predecessors. Computer-aided tracing of cartographic drawings allowed acquisition of restricted historical and important building information. This was time consuming, but provided valuable measurable evidence not only for the building's façade, but also for the determination of convergent building heights, whilst validating cadastral widths.

Atlas.ti – Internal Validation: programmed analysis triangulation

Atlas.ti is software specifically developed for the computer-aided organisation and analysis of qualitative data (Muhr 1997). Primarily used for qualitative data organisation, for theories, and for justifying or disproving arguments, the software allowed extrapolation, connecting and proving each piece of evidence, whilst utilising the coding for a virtual timeline. With the use of *Atlas.ti*, the building information compiled by the students could be updated using strategic analysis and conviction. During the verification of both archive and the cartographic evidence, *Atlas.ti* became a tool of internal triangulation and validation. The large volume of information sourced and produced during this study had made it increasingly difficult to organise everything into one concatenating set: however, with the use of *Atlas.ti*, the pertinent evidence could be linked, justified and portrayed to an audience as a single illustratable compilation. The physical method of extrapolating the information from various verified historic data is tedious and challenging, requiring a large physical space to organise printed evidence. However *Atlas.ti*, digitised this process and served as a platform for triangulating multi-modal evidence including pictorial and written accounts. This became a visual 'internal' triangulation platform that could be consigned to

another researcher to the study without supervision from the platform's designer. *Atlas.ti* effectively became the digital version of the 'evidence board' commonly associated with a stereotypical detective's investigation.

Initially, all relevant documents are assigned to *Atlas.ti* as primary documents. This process links them to the Atlas platform, where they are named correctly and prepared for coding. All documents are linked and opened through the platform, which keeps the Atlas file to a minimum electronic size. It soon became obvious that this link system was essential, since re-organising embedded files would require any files previously placed into the system to be reloaded and reconfigured. Primary documents may therefore be updated at any time, making it easier to remotely update, then re-load files as is necessary with a constantly updated elevation timeline. The initial step whilst using *Atlas.ti* is to identify the codes for use: these codes facilitate the linking of comparable documents in a useable manner. The codes devised in this study were created to match the chronological elevation timeline, whereby there was a code per building per year of significance (e.g. code '1930 Butler Brothers Building') and each was linked directly to the single elevation primary document. The building was coded as a single entity and "filed" into the period of each elevation timeline so as to minimise the codification.

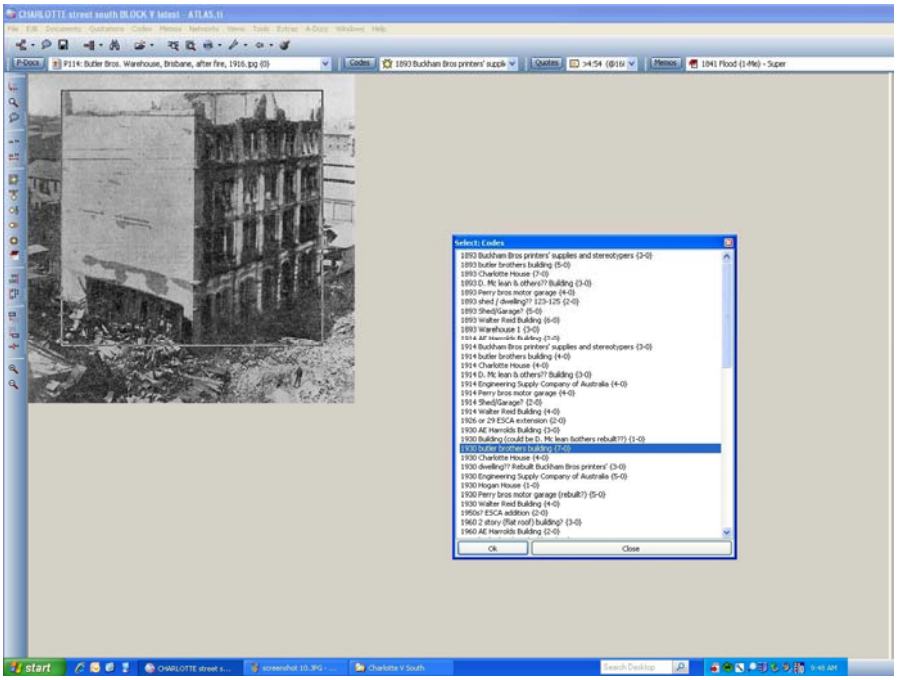

Figure 10- Screen shot depicting cross-referencing of archival image (Source: Authors)

A second layer of coding was used to identify the lot number: this was necessary in order to connect each elevation to a single physical location, and particularly helped with linking

written information which only referred to lot numbers. Once each element has been catagorised by coding, *Atlas.ti* identifies how many primary documents have been linked to that code and the viewer has opportunity to access each directly from the Code Manager. Opening the code manager allows the user to view code occurrences throughout all of the primary documents and, by selecting particular “quotations”, the viewer is directed to the corresponding occurrences.

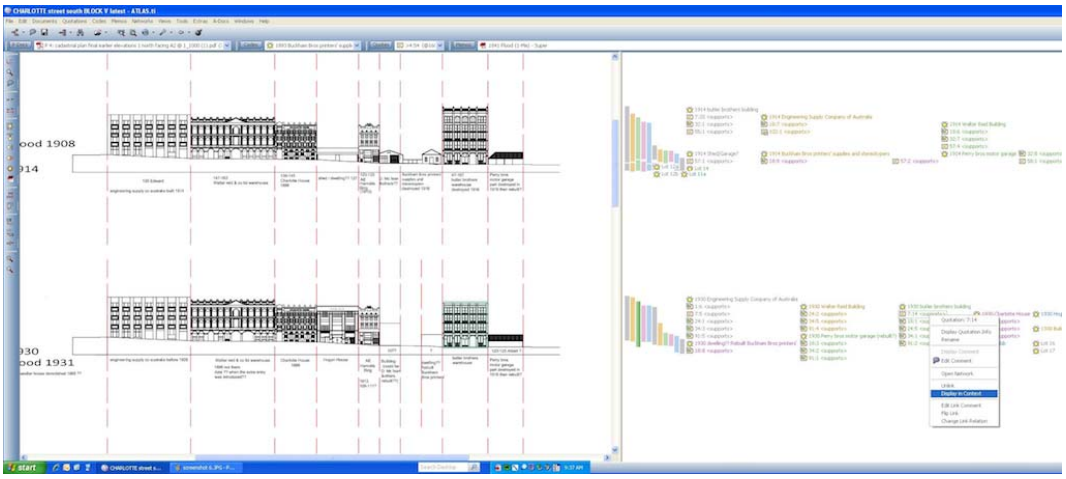

Figure 11- Screen shot depicting cross-referencing of drafted elevations with evidenced data (Source: Authors)

Once codification of each document and elevation had been completed, the linking of documents through the justification method was layered on to all information. Transitive Code-to-Code linking was used to justify the elevation timeline between primary documents, including written accounts, photographic evidence and other supporting documentation. *Atlas.ti* provides a variety of linking options between codes, quotes and memos as contradictory, explanatory and supporting evidence.

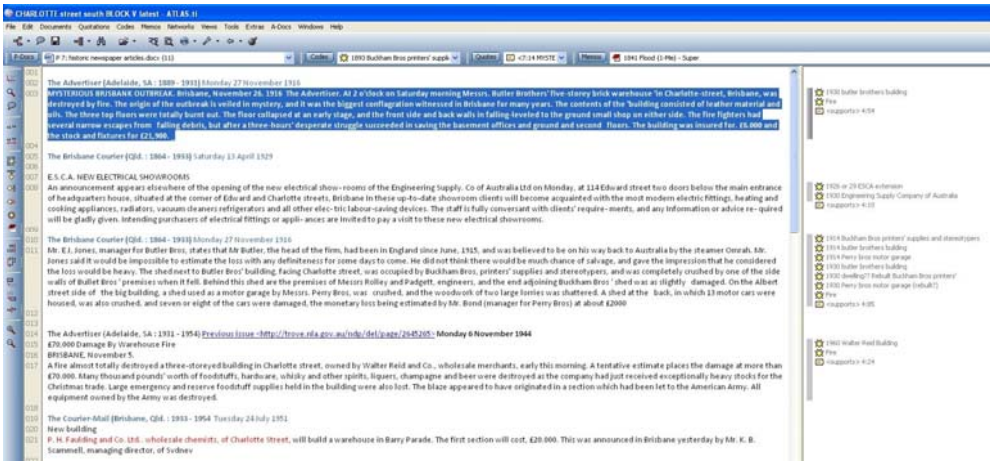

Figure 12- Screen shot depicting cross-referencing of evidenced data including extract from published media (Source: Authors)

By selecting the supporting link in the code display section of the interface, the area relating to it will be highlighted in the document display section of the interface, thus identifying the area of interest, and by right-clicking on the link, and selecting the “display in context” option in the selection menu, *Atlas.ti* will take the viewer directly to the pertinent primary document, without the need for manually searching for that piece of evidence.

Lastly, appended notes and/or memos were valuable, and could be used to extrapolate information for each code and building: they were particularly useful for communicating any additional information to the user.

Conclusion

This paper draws attention to the verisimilitude of historical information, as well as unsatisfactory work presented as complete by novice researchers, and provides an insight into the importance of data verification.

Due to the availability of rich geographic information in Australia, the data collection and mapping study reported in this paper has resulted in the establishment of a significant archive that contains evidence of the urban growth of the central urban area of Brisbane, from colonial settlement to the present.

However, during the process of scrutinizing the data collated by students in this study, numerous inaccuracies were identified. By utilising Atlas.ti software in a novel way, the authors were able to develop a new method of cross-referencing information specific to the paradigm of urban morphological research, so that subsequent analytical phases of any study involving the codification of architectural components within urban forms could be carried out with confidence.

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